



Standard Specification for Wood-Cleated Panelboard Shipping Boxes¹

This standard is issued under the fixed designation D 6251/D 6251M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers the fabrication and closure of empty and full wood-cleated, hereafter referred to as wood-cleated, panelboard boxes. These boxes are intended for use as containers for domestic and overseas shipment of general materials and supplies, not exceeding 1000 lb [454 kg] depending on box type (see 10.1).

1.2 Wood-cleated panelboard shipping box performance is dependent on its fabricated components and subsequent assembly; therefore, a variety of types, classes, styles, and treatments reflecting varied performance are specified. This specification, however, does not cover wood-cleated panelboard box performance under all atmospheric, handling, shipping, and storage conditions.

1.3 If the use of other construction methods or techniques is acceptable and permitted (see 5.1.17), the resulting packaging systems shall be of equal or better performance than would result from the use of these specified materials and procedures. The appropriate distribution cycle, specified in Practice D 4169, can be used to develop comparative procedures and criteria.

1.4 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from the two systems may result in nonconformance with the standard. See IEEE/ASTM SI 10 for conversion of units.

1.5 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of the standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 996 Terminology of Packaging and Distribution Environments²
- D 1990 Practice for Establishing Allowable Properties for Visually-Graded Dimension Lumber from In-Grade Tests of Full-Size Specimens³
- D 3951 Practice for Commercial Packaging²
- D 3953 Specification for Strapping, Flat Steel and Seals²
- D 4169 Practice for Performance Testing of Shipping Containers and Systems²
- D 4727/D 4727M Specification for Corrugated and Solid Fiberboard Sheet Stock (Container Grade) and Cut Shapes²
- D 6199 Practice for Quality of Wood Members of Containers and Pallets²
- F 1667 Specification for Driven Fasteners, Nails, Spikes, and Staples⁴
- IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System⁵
- 2.2 *Federal Specifications:*
 - A-A-58078 Plastic Board (For Packaging Applications)⁶
 - FF-F-133 Fasteners, Wood Joint, Corrugated – (Saw Edge)⁶
- 2.3 *Code of Federal Regulations:*
 - CFR Parts 107-180 Title 49, Hazardous Materials Regulations⁷
- 2.4 *APA—The Engineered Wood Association:*
 - PRP-108 Performance Standards and Policies for Structural-Use Panels⁸
 - PS1-95 Construction and Industrial Plywood⁸
 - PS2-92 Performance Standard for Wood-Based Structural-Use Panels⁸
- 2.5 *American Wood-Preservers' Association (AWPA):*
 - P8-99 Standard for Oil-Borne Preservatives⁹

² Annual Book of ASTM Standards, Vol 15.09.

³ Annual Book of ASTM Standards, Vol 04.10.

⁴ Annual Book of ASTM Standards, Vol 01.08.

⁵ Annual Book of ASTM Standards, Vol 14.02.

⁶ Available from the Federal Supply Service Bureau, Specification Section, Suite 8100, 480 L'Enfant Plaza, SW, Washington, DC 20408.

⁷ Available from the Superintendent of Documents, US Government Printing Office, Mail Stop: SSOP, Washington, DC 20402-9328.

⁸ Available from APA—The Engineered Wood Association, 7011 South 19th Street, P.O. Box 11700, Tacoma, WA 98411-0700.

⁹ Available from American Wood-Preservers' Association, P.O. Box 5690, Granbury, TX 76049.

¹ This specification is under the jurisdiction of ASTM Committee D10 on Packaging and is the direct responsibility of Subcommittee D10.26 on Shipping Containers, Crates, Pallets, Skids, and Related Structures.

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P9-98 Standards for Solvents and Formulations for Organic Preservative Systems⁹

2.6 *Hardwood Plywood and Veneer Association:*

HPVA HP-1-1994 Hardwood and Decorative Plywood¹⁰

2.7 *National Lumber Grades Authority (NLGA):*

Standard Grading Rules for Canadian Lumber, 1996 Edition, Printed Dec. 1, 1997¹¹

2.8 *National Motor Freight Traffic Association:*

National Motor Freight Classification¹²

2.9 *Northeastern Lumber Manufacturers' Association*

(NELMA):

Standard Grading Rules: NELMA¹³

2.10 *Northern Softwood Lumber Bureau (NSLB):*

Standard Grading Rules: NSLB¹⁴

2.11 *Southern Pine Inspection Bureau (SPIB):*

1994 Grading Rules for Southern Yellow Pine¹⁵

2.12 *Uniform Classification Committee Standard:*

Uniform Freight Classification¹⁶

2.13 *West Coast Lumber Inspection Bureau (WCLIB):*

Standard Grading Rules Number 17 - WCLIB¹⁷

2.14 *Western Wood Products Association (WWPA):*

Western Lumber Grading Rules - 98¹⁸

3. Terminology

3.1 General definitions for packaging and distribution environments are found in Terminology D 996.

4. Classification

4.1 *Type* (see 4.3):

4.1.1 *Type I*—Corrugated plastic.

4.1.2 *Type II*—Corrugated and solid fiberboard.

4.1.3 *Type III*—Plywood and oriented strand board (OSB) (only Style A, B, I, and J).

4.2 *Class*:

4.2.1 *Class 1*—Domestic (see 10.1.1).

4.2.2 *Class 2*—Overseas (see 10.1.2).

4.3 *Style* (see Fig. 1 and 10.1):

4.3.1 *Style A*—Standard box corner (see Fig. 2).

4.3.2 *Style A1*—Type I and II, Style A, modified with skids and when specified (see 5.1.3) unnailed top panel closure (see 4.6 and Fig. 3).

4.3.3 *Style B*—Interlocking three-way corners (see Fig. 4).

¹⁰ Available from Hardwood Plywood and Veneer Association, P.O. Box 2789, Reston, VA 22090-0789, American National Standards Institute (ANSI) adopted.

¹¹ Available from National Lumber Grades Authority, #406-960 Quayside Drive, New Westminster, B.C., Canada, V3M6G2.

¹² Available from National Motor Freight Traffic Association, American Trucking Associations, 2200 Mill Road, Alexandria, VA 22314.

¹³ Available from Northeastern Lumber Manufacturers Association (NELMA), 272 Tuttle Road, P.O. Box 87A, Cumberland, ME 04021.

¹⁴ Available from Northern Softwood Lumber Bureau (NSLB), 272 Tuttle Road, P.O. Box 87A, Cumberland, ME 04021.

¹⁵ Available from Southern Pine Inspection Bureau, 4709 Scenic Highway, Pensacola, FL 32504-9094.

¹⁶ Available from the Uniform Classification Committee, Tariff Publishing Officer, 151 Ellis St. N.E., Suite 200, Atlanta, GA 30335-6021.

¹⁷ Available from West Coast Lumber Inspection Bureau (WCLIB), 6980 SW Varns Street, Tigard, OR 97223.

¹⁸ Available from Western Wood Products Association, 522 SW Fifth Avenue, Suite 500, Portland, OR 97204-2122.

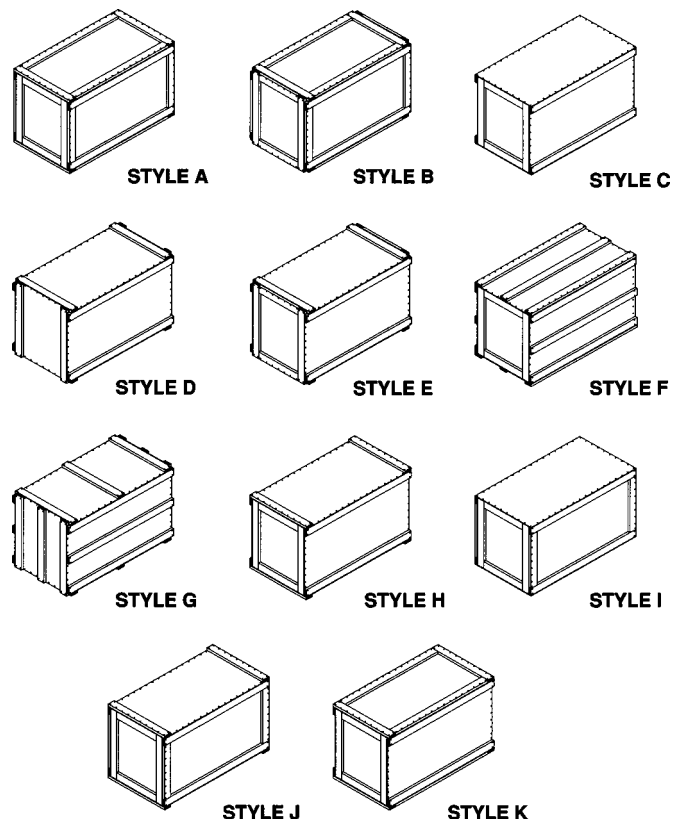


FIG. 1 Styles of Cleated Panel Boxes

4.3.4 *Style C through K*—Limited only to Type II, Class 1 (see 5.1.2 and Fig. 1).

4.3.5 *Style A, B, I, and J*—Type III limited only to these styles (see 5.1.2 and Fig. 1)

4.4 *Water-Repellent Wood Preservative* (see 5.1.13):

4.4.1 *Treatment A*—Without water-repellent wood preservative.

4.4.2 *Treatment B*—With water-repellent wood preservative.

4.5 *Load Type* (see 5.1.19 and 10.2):

4.5.1 *Type 1*—Easy.

4.5.2 *Type 2*—Average.

4.5.3 *Type 3*—Difficult.

4.6 *Unnailed Top Panel Closure Option*—When specified (see 4.3.2 and 5.1.3), Type I and II, Style A1, or Type III, Style A or B shall have the top panel modified (see 7.1.8) and closed with flat steel strapping as specified in the Supplemental Requirements. Securing the top panel to the box with other than flat steel strapping shall be prohibited.

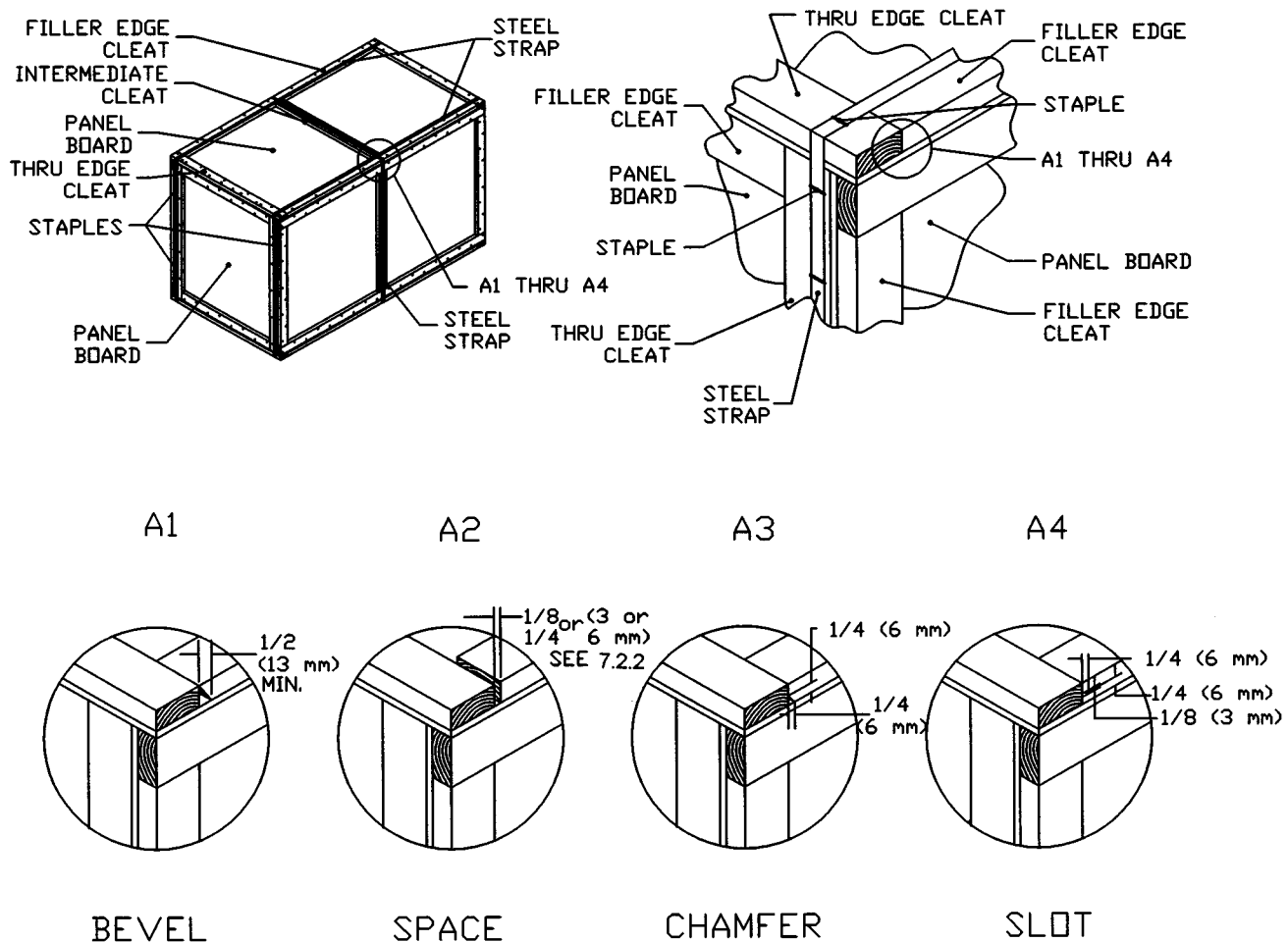
4.7 *Part Number*—If required, a specification part number for boxes described in this specification can be formulated (see S3.3).

5. Ordering Information

5.1 Purchasers shall select the preferred permitted options and include the following information in procurement documents:

5.1.1 Specification title, number, and date.

5.1.2 Box type, class, style, preservative treatment, load type, and closure required (see 4.1-4.6, and 6.5).



A - FILLER AND INTERMEDIATE CLEAT ENDS AND RELATION TO THROUGH EDGE CLEATS

FIG. 2 Style A Box

5.1.3 When Type I and II, Style A1; or Type III, Style A or B, unnailed top panel closure is required (see 4.3, 4.6, and 7.1.8).

5.1.4 Contents weight (see Tables 2-9).

5.1.5 Cleat lumber quality classification required (see 6.3).

5.1.6 Lumber quality used for skid fabrication (see 6.3).

5.1.7 Intermediate cleat requirements for Type III, Class 1 and Class 2, Style I and J (see 7.2.2).

5.1.8 When skids are not required for boxes with gross weights of 200 lb [91 kg] or 100 lb [45 kg] with dimensions of 48 by 24 in. [1219 by 610 mm] or more (see 7.7.2).

5.1.9 When beveled skids are required (see 7.7.2).

5.1.10 When four-way entry skids are required and when 3 1/2 by 4-in. [89 by 102-mm] built-up skids are required (see 7.7.3).

5.1.11 Whether container manufacturer's identification is required (see 7.8).

5.1.11.1 Whether modifications to container manufacturer's identification are required (see 7.8.6).

5.1.12 Box dimensions (inside measurements, panel to panel) specified in order of length by width by depth (see 7.5).

5.1.13 When water-repellent wood preservative treatment is required for plywood and cleats (see 4.4 and 6.5).

5.1.14 Whether boxes are to be shipped assembled or knocked-down (see 9.1).

5.1.15 When Class 1 boxes require external strapping (see S1.1).

5.1.15.1 When Class 2 boxes do not require strapping (see S1.1).

5.1.16 When seal joint specimens are required prior to strapping operations (see S3.1.1).

5.1.17 Whether other construction methods or techniques are acceptable and permitted (see 1.3).

5.1.17.1 Whether proof is required that other construction methods or techniques are acceptable (see 1.3).

5.1.18 Whether sanded plywood and cleats are required (see 6.2.3.2 and 6.5.3).

5.1.19 Load type (see 4.5).

5.1.20 Whether alternate fastening systems to secure the cleated box panels together are allowed (see 6.4.6).

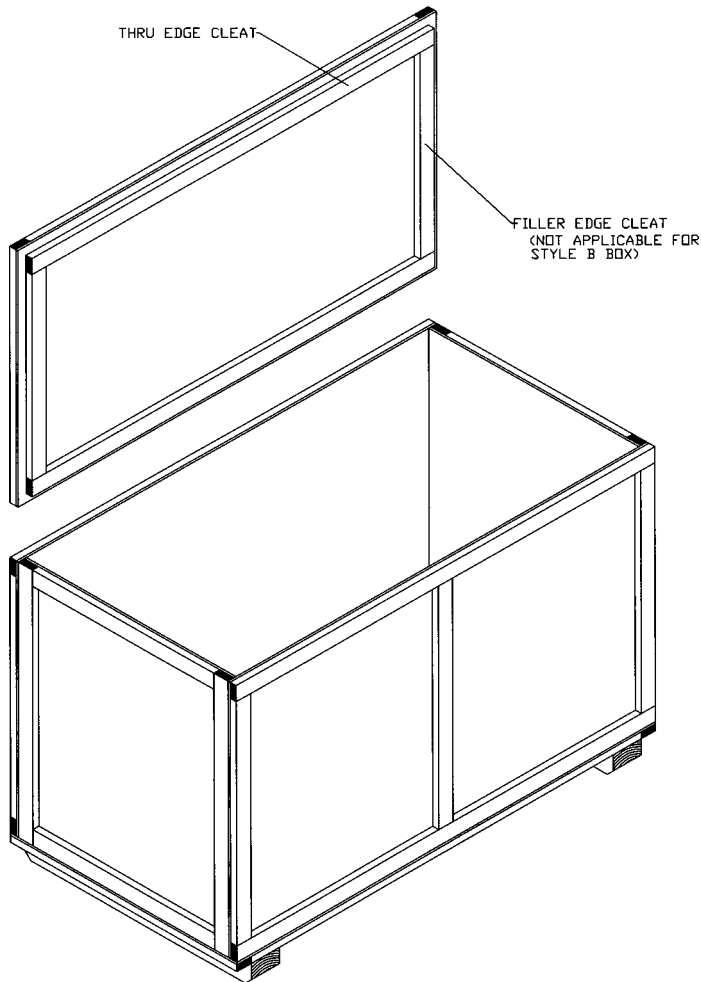


FIG. 3 Unnailed Top Panel Closure

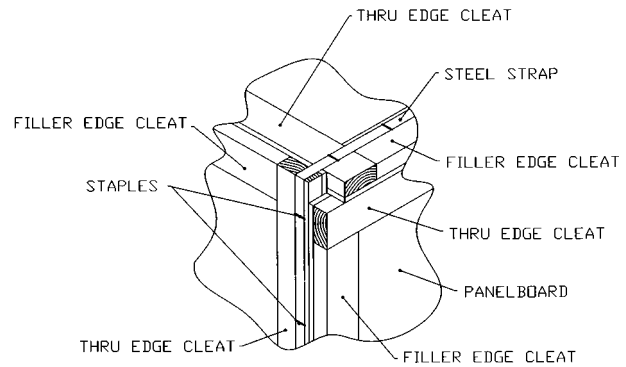
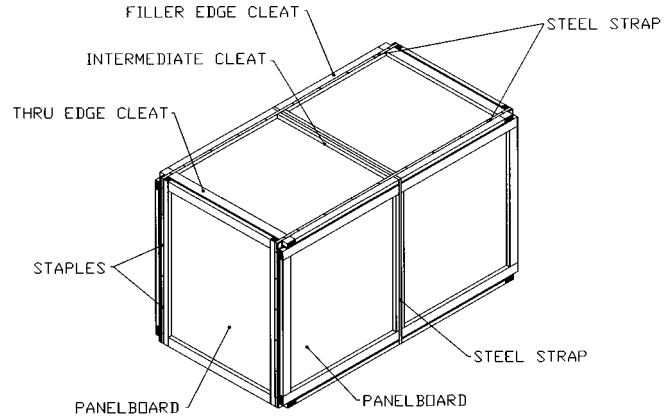


FIG. 4 Style B Box

TABLE 1 Lumber Commercial Standards

Rules	Grade ^{A,B}		
NLGA ^C			
NELMA ^D			
SPIB ^E	Construction	Light	Framing
WCLIB ^F			
WWPA ^G			
NSLB ^H			

^A Structural design values greater (12.5 %) than Structural No. 3, but slightly (10 %) less than Structural No. 2.

^B Wood shall be completely bark free to prevent spread of Oak Wilt disease.

^C Standard Grading Rules for National Lumber Grades Authority.

^D Standard Grading Rules for Northeastern Lumber Manufacturers Association.

^E Standard Grading Rules for Southern Pine Inspection Bureau.

^F Standard Grading Rules for West Coast Lumber Inspection Bureau.

^G Standard Grading Rules for Western Wood Products Association.

^H Standard Grading Rules for Northern Softwood Lumber Bureau.

6. Materials and Manufacture

6.1 *Materials*—It is encouraged that recycled material be used when practical. All recovered, recycled, or virgin materials used in the box manufacture shall meet the requirements of this specification and referenced documents. In addition, materials shall not affect or be affected by the product being packed. Type II panelboard shall have no more than 40 % post consumer recovered material.

6.2 *Panelboard*—Panelboard shall be as specified (5.1.2).

6.2.1 *Type I*—Panelboard shall be polyethylene, containing ½ % ultraviolet (UV) inhibitor and shall conform to A-A-58078, Type II, or commercial equivalent. The plastic panel basis weight shall be 245 to 255 lb/1000 ft² [1195 to 1245 g/m²].

6.2.2 *Type II*—Panelboard shall be fiberboard conforming to Specification D 4727/D 4727M. Class 1 and Class 2 boxes, singlewall (SW), solid (SF), and V board shall conform to the requirements of 7.1.1.

6.2.3 *Type III*—Panelboard for Class 1 boxes shall conform to HPVA HP-1-1994, Type III, Grade 3-4; or PS1-95, Interior with Exterior Glue, Grade C-D. Panelboard for Class 2 boxes shall conform to HPVA HP-1-1994, Type I, Grade 3-4 or PS1-95, Exterior, Grade C-D.

6.2.3.1 As an alternative, panelboard for Class 1 boxes can

also conform to PRP-108, Oriented Strand Board (OSB), Structural 1 rated sheathing with Exposure 1 designation. The strands shall have a ratio of length to width of approximately 3:1. The strands shall be oriented in one direction in each layer and the strands of one layer shall be perpendicular to the strands in adjacent layers. There shall not be less than three layers in each panel. The strands shall be bonded together with a liquid exterior phenolic or an exterior isocyanate resin. The density of ¾-in. [10 mm] thick OSB panels shall be approximately 39 lb/ft³ [624.7 kg/m³].

6.2.3.2 The plywood thickness shall be specified in Tables 3 and 4. Plywood shall have no defects (knot holes, worm holes, and so forth) extending through more than two panel plies. Unless otherwise specified, plywood shall be unsanded. If smooth finish or sanded panels are required, appropriate



TABLE 2 Type II Corrugated and Solid Fiberboard Requirements

Contents Weight Lb [kg]		Class 1		Class 2
Exceeding	Not Exceeding	CF D SW Grades ^A	SF D Grades ^A	SF Grades ^{A,B}
0	75	200	200	V3S or V4S
[0]	[34]			
75	150	275	275	V3S or V4S
[34]	[68]			
150	200	350	350	V3S or V4S
[68]	[91]			
200	300	350	350	...
[91]	[136]			
300	400	...	500	...
[136]	[181]			

^A As defined in Specification D 4727/D 4727M CF or SF (corrugated or solid fiberboard), D (domestic), SW (single-wall), grades as stated.

^B Class 2 boxes are limited to Style A or B and shall not exceed 48-in. [1219-mm] length, 36-in. [914-mm] width, or 36-in. [914-mm] depth.

TABLE 3 Type III, Class 1 Plywood Requirements

Contents Weight lb [kg]		Plywood Min Thickness ^A	
Exceeding	Not Exceeding	PS1-95 and PRP-108 ^{B,C,D} in. [mm]	HPVA HP-1-94 ^{B,E} in. [mm]
0	75	5/16 ^{F,G}	1/8
[0]	[34]	[8]	[3.2]
75	150	5/16 ^{F,G}	1/8
[34]	[68]	[8]	[3.2]
150	300	5/16 ^{F,G}	3/16 ^F
[68]	[136]	[8]	[4.8]
300	500	5/16 ^F	3/16
[136]	[227]	[8]	[4.8]
500	800	5/16	1/4
[227]	[363]	[8]	[6.4]
800	1000	3/8	5/16
[363]	[454]	[9.5]	[8]

^A Commercial tolerances shall apply.

^B See 6.2.3.

^C Alternatively low-density plywood conforming to HPVA HP-1-1994 (see 6.2.3) may be used.

^D OSB panelboard conforming to APA PRP-108 or PS-2-92 and shall be limited to Style A and B boxes.

^E Low density plywood conforming to HPVA HP-1-94 (see 6.2.3) shall not be used.

^F 3/20 in. [3.8 mm] min. thick plywood conforming to HPVA HP-1-1994, Type III, Grade 4, may be used in place of the 5/16 in. [8 mm]. (3/20-in. [3.8-mm] thick plywood is not a standard thickness in PS1-95).

^G At the option of the supplier, 1/4-in. [6.4-mm] sanded plywood may be furnished.

sanded grades should be specified in the contract (see 5.1.18). End grain joints shall be prohibited for Grade 4 veneers. When the plywood is specified to be surface treated with water-repellent wood preservative, the treatment shall be as specified in 6.5.

6.3 *Lumber*—Lumber for cleats shall conform to Practice D 6199, Class 2 (see 7.2) or Table 1, as specified (see 5.1.5). Lumber for skids shall conform to Practice D 6199, Class 3 or in accordance with Table 1, as specified (see 5.1.6).

6.4 *Fasteners*—Testing is not required for fasteners specified in 6.4.1-6.4.3 when used to join panelboard to wood in panel fabrication.

6.4.1 *Nails*—Nails shall be made of steel wire and shall conform to Specification F 1667 and as specified in 7.1 and 7.4.

6.4.2 *Staples or Wire Stitches*—Staples or wire stitches shall be made of steel wire not less than 0.0625 in. diameter (16

gage), [1.59 mm]. The crown bearing surface (the underside) shall be not less than 5/16 in. [8 mm] long except that for Type II boxes the bearing surface shall be not less than 1/2 in. [13 mm] long.

6.4.3 *Single-Leg Fasteners*—Single-leg fasteners shall be formed automatically into a nail from sheared off bright, smooth, knurled, or helically fluted low-carbon steel. Medium carbon steel (stiff-stock) minimum 0.072-in. (15-gage) [1.83-mm] diameter) wire may also be used. Fasteners are driven subsequently by a special machine at a rapid rate, with sheared-bevel or sheared-square point. For Type I and II boxes, the nail length, before driving, shall be a minimum of 1/8 in. [3 mm] longer than the thickness of the material being joined. For Type III boxes, the nail length, before driving, shall be a minimum of 1/2 in. [13 mm] longer than the thickness of the material being joined. The automatic machine for driving shall be provided with needle-point knives, a J-clinch plate, and a 1/32-in. [1-mm] countersink. Single-leg fasteners shall not be used in joining panelboard to cleats.

6.4.4 *Other Fastenings*—Other single-leg fasteners, pre-formed or formed from wire, fastenings may be used to the extent specified in 7.1 but must be tested in accordance with 8.1. Steel wire used to form these fasteners shall have a diameter of not less than 0.0625 in. (16 gage) [1.59 mm]. If wire other than round wire is used, the cross section area shall be equal to that of 0.0625 in. round wire. Fastener points and shanks shall be determined by the test specified in 8.1 for the applicable application and when driven, shall not split the wood members. The fastener withdrawal resistance shall be equal to nails specified in 6.4.1. These fasteners, when used, shall be driven so as to provide a minimum clinch of 1/8 in. [3 mm] and shall not be used with plywood less than 1/4 in. [6.4 mm] thick.

6.4.5 *Corrugated Fasteners*—Corrugated fasteners shall only be used on Type I and II boxes and shall conform to FF-F-133, or commercial equivalent, and as specified in 7.1.

6.4.6 *Alternate Fastening Systems*—If the use of alternate fastening systems is acceptable or permitted (see 5.1.20), these systems can be used to secure the box cleated panels together (see 7.6).

6.5 *Water-Repellent Wood Preservative*—Water-repellent wood preservative shall be composed of either a 2 % copper naphthenate, a 3 % zinc naphthenate, or a 1.8 % oxine copper (formerly referred to as copper-8-quinolinolate) solution. Treating solutions shall conform to AWPA Standard P8 or P9.

6.5.1 *Type I and II*—When specified (see 4.4 and 5.1.13) Type I and II boxes shall have the wood cleats treated with a water-repellent wood preservative specified in 6.5 applied by immersion.

6.5.2 *Type III*—Under some conditions of exposure, Type III boxes may become stained and discolored by molds and mildew. Such staining is undesirable when the identification markings may become obscured. Water-repellent preservatives are effective in retarding mildew and similar stains. Type III boxes shall be treated such that the plywood absorbs not less than 2.2-lb/100 ft² [10.74 kg/100 m²] water-repellent wood preservative.

6.5.3 When sanded plywood and cleats are specified (see

TABLE 4 Type III, Class 2 Plywood Requirements

Contents Weight lb [kg]		Plywood Min Thickness ^A							
		Type 1 and 2 Loads				Type 3 Load			
Exceeding	Not Exceeding	PS1-95 ^{B,C} in. [mm]		HPVA HP-1-94 ^{B,D} in. [mm]		PS1-95 ^{B,C} in. [mm]		HPVA HP-1-94 ^{B,D} in. [mm]	
		Style		Style		Style		Style	
		A and B	I and J ^E	A and B	I and J ^E	A and B	I and J ^{E,F}	A and B	I and J ^{E,F}
0	100	5/16 ^G	3/8	3/16 ^H	5/16	5/16 ^G	3/8	3/16 ^F	5/16
[0]	[45]	[8]	[9.5]	[4.8]	[8]	[8]	[9.5]	[4.8]	[8]
100	200	5/16 ^G	3/8	3/16 ^H	5/16	5/16 ^G	3/8	3/16	5/16
[45]	[91]	[8]	[9.5]	[4.8]	[8]	[8]	[9.5]	[4.8]	[8]
200	300	5/16 ^G	1/2	3/16	3/8	5/16	15/32	1/4	3/8
[91]	[136]	[8]	[12.7]	[4.8]	[9.5]	[8]	[11.9]	[6.4]	[9.5]
300	400	5/16 ^G	1/2	3/16	3/8	5/16	15/32	1/4	3/8
[136]	[181]	[8]	[12.7]	[4.8]	[9.5]	[8]	[11.9]	[6.4]	[9.5]
400	500	5/16 ^G	1/2	3/16	3/8	5/16	19/32	1/4	1/2
[181]	[227]	[8]	[12.7]	[4.8]	[9.5]	[8]	[15.1]	[6.4]	[12.7]
500	600	5/16	1/2	1/4	3/8	5/16	19/32	1/4	1/2
[227]	[272]	[8]	[12.7]	[6.4]	[9.5]	[8]	[15.1]	[6.4]	[12.7]
600	800	3/8	5/8	5/16	1/2	3/8	19/32	5/16	5/8
[272]	[363]	[9.5]	[15.9]	[8]	[12.7]	[9.5]	[15.1]	[8]	[15.9]
800	1000	3/8	5/8	5/16	1/2	3/8	19/32	3/8	5/8
[363]	[454]	[9.5]	[15.9]	[8]	[12.7]	[12.7]	[15.1]	[9.5]	[15.9]

^A Commercial tolerances shall apply.

^B See 6.2.3.

^C Alternatively low density plywood conforming to HPVA HP-1-1994 (see 6.2.3) may be used.

^D Low density plywood conforming to HPVA HP-1-94 (see 6.2.3) shall not be used.

^E Only Style I and J, top and bottom panels, all other panels as specified for Style A and B.

^F For Air Force shipments, Style I and J contents maximum weight shall be 150 lb [65 kg].

^G At the option of the supplier, 1/4-in. [6.3-mm] sanded plywood may be furnished.

^H 3/20 in. [3.8 mm] min. thick plywood conforming to HPVA HP-1-1994, Type I, Grade 4, may be used in place of the 3/16-in. [4.8-mm] thick plywood. (3/20-in. [3.8-mm] thick plywood is not a standard thickness in PS1-95).

TABLE 5 Cleat Sizes for Type I Panels

Contents Weight lb [kg]		Class 1 Cleat Size in. [mm] ^A		Class 2 Cleat Size in. [mm] ^A	
Exceeding	Not Exceeding	Min Width	Min Thickness	Min Width	Min Thickness
0	100	1 3/4	3/4	1 3/4	3/4
[0]	[45]	[35]	[16]	[35]	[16]
100	150	1 3/4	3/4	2 1/4	3/4
[45]	[68]	[35]	[16]	[45]	[16]
150	225	2 5/8	3/4	2 5/8	3/4
[68]	[102]	[54]	[16]	[54]	[16]
225	250	3	3/4	3	3/4
[102]	[113]	[64]	[16]	[64]	[16]
250	300	3	3/4	3	3/4
[113]	[136]	[64]	[16]	[64]	[16]
300	350	3	3/4	3	3/4
[136]	[159]	[64]	[16]	[64]	[16]
350	400	3	3/4	3	3/4
[159]	[181]	[64]	[16]	[64]	[16]
400	500	3	3/4
[181]	[227]	[64]	[16]		

^A Practice D 6199 dimension requirements apply.

5.1.18, and 6.2.3.2), the plywood shall be sanded prior to surface treatment. Wood shall be preserved by immersing in wood preservative for a minimum of three minutes prior to use in panel fabrication. There shall be evidence of discoloration of the plywood and wood cleats when tested in 8.4 for presence of preservative. The preservative shall be dry prior to assembling cleats to the panelboard or painting the cleats (see 6.5.5). When boxes are painted, wood preservation shall be accomplished prior to paint application.

6.5.4 In general, the copper naphthenate solution is the preferred wood preservative unless end items to be packaged in

TABLE 6 Cleat Sizes for Type II Panels

Class 1					
Contents Weight lb [kg]			Min Cleat Size, min ^A		
			Thickness		Width
Box Style	Exceeding	Not Exceeding	Group I and II Woods in. [mm]	Group III and IV Woods in. [mm]	All Groups of Woods in. [mm]
C thru K	0	75	11/16	5/8	1 1/2
	[0]	[34]	[16]	[14]	[32]
C thru K	74	150	3/4	11/16	1 1/4
	[35]	[68]	[16]	[16]	[37]
A and B	0	75	5/8	9/16	1 1/2
	[0]	[34]	[14]	[13]	(32)
A and B	75	150	11/16	5/8	1 1/4
	[34]	[68]	[16]	[14]	[37]
A and B	150	300	3/4	11/16	1 3/4
	[68]	[136]	[16]	[16]	[35]
A and B	300	400	1	13/16	1 3/4
	[136]	[181]	[19]	[16]	[35]

Class 2				
Contents Weight lb [kg]		Cleat Min Size for all Wood Groups in. [mm] ^A		
Box Style	Exceeding	Not Exceeding	Thickness, min	Width, min
A or B	0	200	3/4	1 3/4
Only	[0]	[91]	[16]	[35]

^A Practice D 6199 dimension requirements apply.

these boxes are food items not packaged in sealed metal cans or materials which might be adversely effected by residual solvents from the wood preservative. The purchaser should be consulted if there is a question concerning the appropriate wood preservative (see 5.1.2).



TABLE 7 Cleat Sizes for Type III, Class 1 Panels

Contents Weight lb [kg]		Cleat Size ^{A,B} in. [mm]	
Exceeding	Not Exceeding	Thickness	Width
0	75	3/4	1 3/8
[0]	[34]	[16]	[29]
75	150	3/4	1 3/4
[34]	[68]	[16]	[35]
150	300	3/4	1 3/4
[68]	[136]	[16]	[35]
300	500	3/4	1 3/4
[136]	[227]	[16]	[35]
500	800	3/4	2 1/4
[227]	[363]	[16]	[45]
800	1000	3/4	2 5/8
[363]	[454]	[16]	[54]

^A Practice D 6199 dimension requirements apply.^B All wood groups.

TABLE 8 Cleat Sizes for Type III, Class 2 Panels

Contents Weight lb [kg]		Edge Cleat Size ^{A,B} in. [mm]	
Exceeding	Not Exceeding	Thickness	Width
0	100	3/4	1 3/4
[0]	[45]	[16]	[35]
100	200	3/4	1 3/4
[45]	[91]	[16]	[35]
200	300	3/4	1 3/4
[91]	[136]	[16]	[35]
300	400	3/4	1 3/4
[136]	[181]	[16]	[35]
400	500	3/4	2 1/4
[181]	[227]	[16]	[45]
500	600	3/4	2 5/8
[227]	[272]	[16]	[54]
600	800	3/4	3 1/4
[272]	[363]	[16]	[70]
800	1000	3/4	3 1/4
[363]	[454]	[16]	[70]

^A Practice D 6199 dimension requirements apply.^B All wood groups.

TABLE 9 Nails and Staples Sizes for Joining Panelboard and Cleats

lb [kg]	Wire Gage [mm]	Nails Diameter Not Less Than		Staples and Other Diameter Not Less Than	All Fasteners Length as Specified ^A
		in. [mm]	Head in. [mm]		
0 to 150	15	0.072	1 3/64 ^B	as specified	see 6.4 ^B
[0 to 68]	[1.83]	[1.83]	[5.16]	in 6.4.2,	through
150 to 1000	14	0.080	1 3/64 ^B	6.4.3, and	6.4.4 ^B
[68 to 454]	[2.03]	[2.03]	[5.16]	6.4.4 ^C	

^A Fastening plywood to cleats, not less than the plywood and cleat thickness, plus 1/8-in. [3.2 mm].^B Nail dimensions for Type II, Style C through K shall be not less than 1 in. [25 mm] in length and have not less than 1/4-in. [6.35-mm] head diameter.^C Staple crown for Type II boxes shall be not less than 1/2 in. [13 mm] long.

6.5.5 *Preservative Dryness*—Boxes, or box parts, shall be dried prior to assembling or painting after water-repellent wood preservative is applied. There shall be an absence of discoloration when tested as specified in 8.4.3.

7. Construction

7.1 *Panel Fabrication*—Panels shall be fabricated by nailing, stapling, or gluing panelboard to cleats placed as shown in

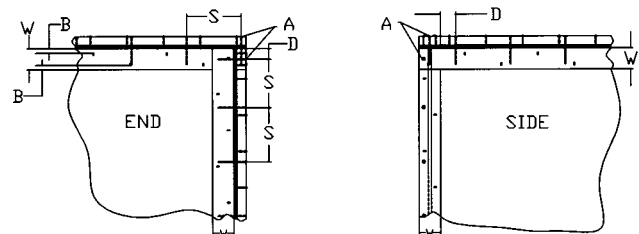
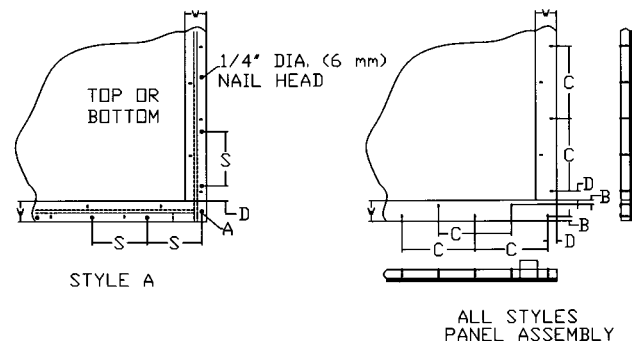
Figs. 1-7 and as specified in 7.2.

7.1.1 *Type I and II Panelboard*—Panelboard material as specified in 6.2.1 and 6.2.2 shall be joined to cleats by fasteners or adhesives to make a panel for a box to carry contents weight as specified in Table 2. Panelboard for one and two piece panels shall be as specified in 7.1.4-7.1.6. The contents weight for Type I panel boxes shall not exceed 500 lb [227 kg] for Class 1 nor more than 400 lb [181 kg] for Class 2. The contents weight for Type II boxes shall not exceed 400 lb for Class 1 nor more than 200 lb [91 kg] for Class 2. The contents weight for Type III boxes shall not exceed 1000 lb [454 kg] for Class 1 or Class 2. Adhesives shall not be used to secure plastic panelboard to cleats.

7.1.2 *Type III Panelboard*—Plywood panelboard material as specified in 6.2.3 shall be joined to cleats by use of either nails, staples, wire stitches, or other fasteners as specified in 6.4 and Table 9, at the option of the supplier (see Fig. 5, Insert, All Styles Panel Assembly).

7.1.3 *Solid Wood Panels*—Solid wood panels may be used when the box panel length or width dimension is equal to less than the sum of three cleat widths. The wood member thickness shall be 1/16 in. [2 mm] greater than that specified for the cleat thickness for the loads specified in Tables 7 and 8. When solid wood panels are used, plywood inner facings may be omitted.

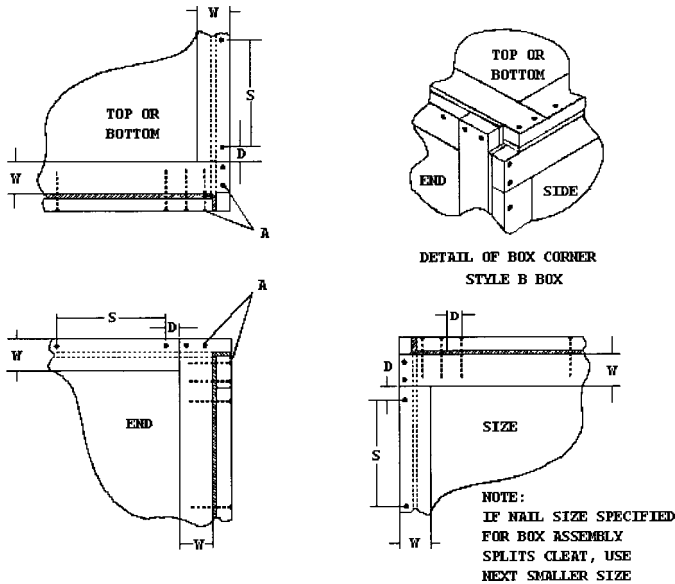
7.1.4 *One and Two Piece Panels*—Box bottom panels not exceeding 72 in. [1829 mm] in length or 48 in. [1219 mm] in



NOTE 1—Symbol Identification:

- A = Two nails required if cleats are 2 1/4 in. [45 mm] or more in width (see 7.4.1).
- B = 3/8 in. [10 mm] = min.
- C = 6 in. [152 mm] = max.
- D = Minimum distance between fastener and end of cleat to be not less than 3/4 in. [19 mm] nor more than 1 1/2 [38 mm].
- S = Box assembly nail spacing (see Table 10 and Table 11).
- W = Cleat width (see Tables 5-8).

FIG. 5 Style A Box Nailing



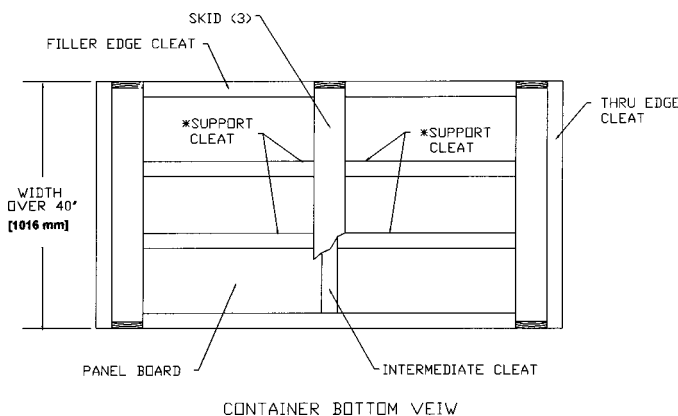
NOTE 1—Panel assembly - nails, staples, or other types of fasteners may be employed at the option of the supplier (see 7.1). Fasteners shall be staggered in two parallel rows as shown.

Box assembly—Dimensions S and D may be varied enough to prevent nails from striking panel assembly nails or to prevent nails from being driven into cracks.

Symbol Identification

- A = Two nails required if cleats are $2\frac{1}{4}$ in. [45 mm] or more in width (see 7.4.1).
- D = Minimum distance between fastener and end of cleat to be not less than $\frac{3}{4}$ in. [19 mm] nor more than $1\frac{1}{2}$ [38 mm].
- S = Box assembly nail spacing (see Table 10 and Table 11).
- W = Cleat width (see Tables 5-8).

FIG. 6 Style B Box Nailing



NOTE 1—Use support cleats to prevent fork-lift tine damage to floor panel when container width is over 40 in. [1014 mm] O.D. and rubbing strips/skids are required.

Locate the support cleats equal distance between filler edge cleats.
1 × 4-in. [19 × 89-mm] (nom) lumber.

FIG. 7 Support Cleats

width, shall consist of a single panelboard piece. Type III, Style I, top and bottom panels, regardless of size, shall consist of a single piece of plywood. All other panels of Type III, all style boxes, and all Type I and II, Style A, A1, and B, box panels

shall consist of one or two panelboard pieces joined by either a lap (see 7.1.5) or butt joint (see 7.1.6 and 7.1.7) as specified. In two piece panels, each panelboard piece shall be not less than 24 in. [610 mm] in length or width. Panelboard joints in adjacent panels shall be not closer than 12 in. [305 mm] of being in line with adjacent parallel joints. Adjacent panels may be designed for assembly with joints running perpendicular to each other.

7.1.5 Lap Joint—Adjacent panelboard edges shall be lapped not less than 3 in. [76 mm] and fastened by metal stitches, as specified in 6.4.2, which shall pass through both pieces and are clinched. There shall be not less than two parallel rows of stitches spaced not less than 2 in. [51 mm] apart, and the spacing of stitches in each row shall not exceed 4 in. [102 mm]. Type II, Class 1, fiberboard panelboard lap joints may be firmly joined together with water-resistant adhesive. The fiberboard panel lap joints shall be firmly joined to each other over the entire contact surface area. When tested in accordance with 8.2.3, the fiberboard, or a layer of fiberboard, shall remain in contact with not less than 75 % of the other fiberboard piece contact area. Type III maximum plywood thickness for this type of joint shall be $\frac{3}{16}$ in. [5 mm].

7.1.6 Type I and II Butt Joint—Adjacent panelboard edges shall be butted at the mid-width of a joint cleat and each pie fastened to the cleat. Fastening panelboard to cleats using metal stitches shall be in accordance with 7.1.5 passing through the fiberboard and into the cleat. When the panelboard joint glued to the cleat, the fiberboard butt joint area shall be glued over the entire surface contact area. When tested in accordance with 8.2.3, the fiberboard, or a layer of fiberboard, shall remain in contact with not less than 75 % of the cleat contact area.

7.1.7 Type III Butt Joint—Adjacent panelboard edges shall be butted at the mid-width of a joint cleat specified in 7.1.7.1 or 7.1.7.2 and each piece fastened to the cleat. Fastening shall conform to the panel fabrication requirements of 7.1.2. The joint cleat length shall be not less than the distance between edge cleats $-\frac{1}{8}$ in. [-3 mm].

7.1.7.1 Class 1 joint cleat thickness shall be the same as the edge cleats. The joint cleat width shall be not less than $2\frac{1}{4}$ in. [57 mm], except if the edge cleat width is greater than $2\frac{1}{4}$ in., the joint cleat shall be the same width as the edge cleat.

7.1.7.2 Class 2 joint cleat thickness shall be as specified for edge cleats and the width shall be not less than $1\frac{1}{3}$ times the required edge cleat width, but under no circumstances shall the cleat width be less than $2\frac{1}{4}$ in. [57 mm].

7.1.8 Top Panel Modification for Unnailed Top Panel Closure—Type I and II, Style A1, or Type III, Style A or B box top panels shall be modified by providing through and filler edge cleats on the panel underside (see Fig. 3). The Type III, Style B top panel shall be modified by providing through edge cleats only on the panel underside. The underside cleats shall be the same width and thickness as required for the outer cleats. Inside through cleats shall be used to reinforce the box ends' inside top edge (see Fig. 3). The underside cleats shall be positioned on the panel so the cleat edges fit snugly within the applicable box side and end panels. Intermediate or reinforcing cleats required for the Style A and B box top panels are not applicable for cleating the underside of the top panel.



7.2 Cleats—Cleats shall be made from wood specified in 6.3. The cleat size shall be as specified in Tables 5-8 as applicable. Cleat arrangement on panels shall be as shown in Figs. 1-7. When assembling cleats to panelboard, the clearance between each filler or intermediate cleat end and the through cleat shall be approximately equal or approximately $\frac{1}{8}$ in. [3 mm] shorter on each end (See Fig. 2, Inserts A1 through A4).

7.2.1 Top and Bottom Panel Cleats—Filler cleats on top and bottom panels, except on top only when the box is provided with skids, shall be either the same length, or up to $\frac{1}{4}$ in. [6 mm] shorter on each end, as the distance between the through edge cleats. If filler cleats are the same length as the distance between through edge cleats, each end shall be cut or notched as shown (Fig. 2, Inserts A1 through A4) for water drainage. The cut or notch clear area shall be adjacent to the panelboard and the filler cleat end shall abut the through cleat edge when the panel is assembled. Provisions for drainage are not applicable for cleats placed on the underside of the unnailed closure Style A box top panels. Intermediate cleats and additional cleats shall be as specified in 7.2.2 and 7.2.3.

7.2.2 Intermediate Cleat Requirements for Box Panels, Class 1 and Class 2, with Type 1 or 2 Loads, (see 4.5)—When one or both panel dimensions measured between the edge cleats inside edge, (unframed area) exceeds 24 in. [610 mm] for Class 1 and Class 2, Style A and B, one or more intermediate cleats of the same width and thickness as the edge cleats shall be applied. These cleats shall be applied perpendicular to the greater of the two dimensions between the edge cleats. The distance between edge cleats, which are parallel with the intermediate cleats, or between intermediate cleats, shall not exceed 24 in. [610 mm]. When both panel dimensions (unframed area) exceed 24 in. and are approximately the same dimensions, the intermediate cleat(s) shall be perpendicular to the filler edge cleats on the ends, top, and bottom, and perpendicular to the through edge cleats on the sides.

7.2.2.1 Regardless of panel size, intermediate cleats are not required perpendicular to the required intermediate cleats unless their purpose is for splicing two pieces of plywood panels larger than 72 by 48 in. [1829 by 1219 mm]. Intermediate cleats for Type III, Class 1 and 2, Style I and J shall be as specified (see 5.1.7). The intermediate cleats drainage requirements on top and bottom panels shall be as specified in 7.2.1 for filler edge cleats. Cleat spacing for Type II, Class 2 boxes, shall be as for all other boxes except that the spacing shall be not more than 20 in. [508 mm].

7.2.3 Additional Cleats—Any box panel having the load concentrated near the center of an unframed area shall be reinforced with an additional cleat of the same width and thickness as the edge cleat.

7.2.4 Type I and II, Class 1 Joint Cleat—Each joint cleat thickness for Class 1 boxes shall be the same as the edge cleats. Each joint cleat width shall be not less than $2\frac{1}{4}$ in. [45 mm], except if the edge cleat width is greater than $2\frac{1}{4}$ in., the joint cleat shall be the same width as the edge cleat. The joint cleat length shall not be less than the distance between edge cleats. The maximum deviation shall be minus $\frac{1}{8}$ in. [3 mm].

7.2.5 Type I and II, Class 2 Joint Cleat—Each joint cleat thickness shall be as specified for edge cleats and the width

shall be not less than $1\frac{1}{3}$ times the required edge cleat width. Under no circumstances shall the cleat width be less than $2\frac{1}{4}$ in. [45 mm].

7.3 Fastening Panelboard to Cleats—Testing is not required for fasteners specified in 6.4.1-6.4.3 when used to join panelboard to wood for panel fabrication. Other fasteners (see 6.4.4) shall be tested as specified in 8.1. Fasteners for joining panelboard to cleats shall conform to 6.4.1 for nails and 6.4.2 for staples and the sizes specified in Table 9. Nails and staples shall be driven through the panelboard and into the cleats. Fastener length shall be long enough to be clinched not less than $\frac{1}{8}$ in. [3 mm]. Fasteners specified in 6.4.3 and 6.4.4 shall be driven through the cleat into the panelboard. Except as specified in 6.4.3, fasteners shall be of such length that a clinch of not less than $\frac{1}{8}$ in. [3 mm] is produced. Shiners (fastener point protrusions) shall not be permitted.

7.3.1 Convergent or divergent staples that are of the specified length, not less than the sum of the panelboard and cleat thickness, plus $\frac{1}{8}$ in. [3 mm], normally will not protrude through the cleats and do not have to be clinched. The fastener bearing surface when driven from panelboard into the cleat shall not be over driven more than $\frac{1}{32}$ in. [1 mm] or 10 % of the panelboard thickness whichever is greater, or $\frac{1}{16}$ in. [2 mm] or 10 % of the cleat thickness whichever is greater, when driven from cleat into panelboard. The average fastener spacing lengthwise of the cleat shall not exceed 3 in. [76 mm] between centers (see Figs. 5 and 6).

7.3.2 Crown type fastener (staples, wire stitches, and so forth) average spacing lengthwise of the cleat, shall not exceed $3\frac{1}{2}$ in. [89 mm] measured between crown centers. The fastener spacing specified in 6.4.3 shall not exceed 2 in. [51 mm], or shall be in the ratio of not less than 3 to 2 for equivalent nail diameter, or not less than an average of 1.3 times as many automatically driven wire nails as comparable nails specified in 6.4.1. The requirements that provide the least spacing between nails shall prevail.

7.3.3 The distance between the nearest fastener edge and the cleat edge shall be not less than $\frac{3}{8}$ in. [10 mm] (see Fig. 5). Also, the distance between the nearest fastener edge and the cleat end shall be not less than $\frac{3}{4}$ in. [19 mm] nor more than $1\frac{1}{2}$ in. [38 mm] (see Dimension D, Figs. 5 and 6). Fasteners positioned lengthwise of a cleat shall be staggered, where possible, to form two parallel rows approximately $\frac{3}{8}$ in. [10 mm] from the cleat edges (see Figs. 5 and 6).

7.3.4 Corrugated Fasteners—Corrugated fasteners only shall be used for fastening butt joints for Type II, Class 1 boxes. The fastener depth shall be not less than $\frac{5}{8}$ in. [16 mm]. Alternatively, staples may be used at the butt joints of all Type II box cleats.

7.4 Box Assembly—Each box shall be in agreement with Figs. 1-7 for the box style specified. Styles A, C, F, H, I, J and K panels shall be joined with standard box corners in accordance with Fig. 5, Style A. Style B, D, E, and G panels shall be joined with interlocking three-way corners in accordance with Fig. 6, Style B.

7.4.1 Nailing—Each nail fastening the panelboard and panel edge cleat to an adjacent panel edge cleat shall be spaced as specified in Table 10 or Table 11, as applicable, for the cleat

**TABLE 10 Class 1 Nail Size and Spacing for Fastening Together Adjacent Cleated Panels**

Cleats Thickness in. [mm]	Max Nail Spacing for all Wood Groups in. [mm]		Nail Size (Penny) for Wood Groups ^A			
	Type 1 and 2 Loads	Type 3 Load	Group I Woods	Group II Woods	Group III Woods	Group IV Woods
9/16 to 5/8 [13 to 14]	6 [152]	5 [127]	6	6	6	5
1 1/32 to 3/4 [7 to 16]	5 [127]	4 [102]	7	7	7	6
3/4 [16]	5 [127]	4 [102]	7	7	7	6
1 3/16 to 1 [14 to 19]	3 [76]	3 [76]	8	7	7	7

^A If the nail protrudes through the last edge cleat or splits cleat; then the next smaller size penny nail shall be used.

TABLE 11 Class 2 Nail Size and Spacing Fastening Together Adjacent Cleated Panels

Cleats Thickness in. [mm]	Max Nail Spacing for all Wood Groups in. [mm]		Nail Size (Penny) for Wood Groups ^A			
	Type 1 & 2 Loads ^B	Type 3 Load ^B	Group I Wood	Group II Wood	Group III Wood	Group IV Wood
3/4 [16]	5 [127]	4 [102]	9	8	7	6

^A If the nail protrudes through the last edge cleat or splits cleat, then the next smaller size penny nail shall be used.

^B For load type (see 4.5).

thickness used (see Dimension S, Figs. 5 and 6). Boxes assembled with the box nails specified in 6.4.1 shall have approximately 10 % more nails than boxes assembled with cooler or sinker nails. When cleats used are 2 1/4 in. [45 mm] or more in width, two nails shall be driven through the cleat near the end into the side of the appropriate cleat on the abutting panel (see Figs. 5 and 6). Nails used in box assembly shall be cement-coated, chemical-etched, or mechanically deformed (screw-type or annular-ring type). Adjacent cleated panels shall be fastened together with coolers, sinkers, corks, or box nails using the nail size and spacing specified in Tables 10 and 11, as applicable.

7.4.2 Staples, Wire Stitches, Single-leg, or Other Fasteners—When used in box assembly, the fasteners shall be tested in accordance with 8.1.

7.4.3 Type I and II, Class 1, Fastening Cleat Ends—Not less than one nail shall pass through each overlapping through cleat end and into the side of the appropriate adjacent panel cleat. If the box contents weight exceeds 150 lb [68 kg] and the cleats are not less than 1 7/8 in. [35 mm] in width, not less than two nails shall pass through each overlapping through cleat end and into the side of the appropriate adjacent panel cleat. When cleats are Group I or II Woods; when cleats are Group III or IV Woods, only one nail shall be used.

7.4.4 Type II, Fastening Uncleated Panel Edges—For Style C to K, inclusive, the fiberboard along each uncleated edge shall be fastened to the cleat on the adjacent panel by nails passing through the fiberboard and into the cleat. Nails shall be not less than 1 in. [25 mm] long. The nail spacing shall not exceed 3 in. [76 mm]. The nail head diameter shall be not less than 1/4 in. [6.35 mm].

7.4.5 Type III Nailing Uncleated Plywood—For Box Style I and J, the plywood panel uncleated edges shall be fastened to the cleat on the adjacent panel by nails passing through the plywood and into the cleat. Nails shall be spaced not more than 3 in. [76 mm] apart. Nails shall be not less than 1 in. [25 mm] longer than the plywood thickness through which the nail passes for Class 1 and not less than 1 3/8 in. [35 mm] longer for Class 2.

7.5 Dimensions—Boxes shall be furnished having the dimensions specified (see 5.1.12). In this specification, box dimensions shall be given in the sequence of length, width, and depth. Unless otherwise specified, box dimensions shall be the inside measurements, panel to panel. The first two dimensions shall be the open box face. A $\pm 1/8$ -in. [± 3 -mm] dimensional tolerance shall be permitted.

7.6 Alternate Fastening Systems—When specified (see 5.1.20) alternate fastening systems can be used to secure the box cleated panels together. The system shall be installed per manufacturer directions in accordance with the box contents weight and construction. The distance between any two fastening components shall not exceed the manufacturer recommendations for the box contents weight and construction.

7.7 Skids—Lumber for skids shall be as specified in 6.3. Unless otherwise specified (see 5.1.6), each box intended for use with loads having a gross weight in excess of 200 lb [91 kg] or when the box gross weight exceeds 100 lb [45 kg] and both the length and width dimensions exceed 48 in. [1219 mm] by 24 in. [610 mm], respectively, then each box shall be provided with a minimum of two skids.

7.7.1 Additional Skids—Additional skids shall be provided when the distance between skids, measured between the inside edges, exceeds 48 in. [1219 mm]. Additional skids, as required, shall be positioned so as to divide the area between the end skids into units of equal space. When boltholes are provided in an end item or equipment, additional skids, if required, shall be located so as to enable the item to be bolted to the skids.

7.7.2 Skid Size and Location—Skids, or built-up skids and rubbing strips shall be a minimum of 2 1/2 in. [64 mm] high and 3 1/2 in. [89 mm] wide. The skids shall be placed parallel to and extend the full width of the box, the shortest box bottom dimension, and shall be set not less than 2 1/2 in. or more than 1/6 the box length from each end. When specified (see 5.1.9), a bevel of 45° ($\pm 5^\circ$) shall be applied to the 3/4 in. [19 mm] portion of the skid ends. This shall apply to boxes intended for use with loads having a gross weight in excess of 500 lb [227 kg], or those that are Style I, and when skids only are used. When rubbing strips are used in conjunction with skids, the skid ends will not be beveled and the rubbing strips will be set back from the skid ends 2 1/2 to 4 in. [64 to 102 mm] to allow for sling placement.

7.7.3 Four-Way Entry—When four-way fork entry is required (see 5.1.10), skids shall be nominal 4 by 4 in. [89 by 89 mm]. Skids shall be placed lengthwise not less than 1 1/2 in. [38 mm] nor more than 2 1/2 in. [64 mm] from the container sides. Skids shall be cut out a minimum of 2 in. [51 mm] in depth and of such width as to accommodate forks and slings for handling. When specified (see 5.1.10), four-way fork entry shall be accomplished with built-up skids and rubbing strips having

minimum dimensions of 3½ in. [89 mm] wide and 4 in. [102 mm] high (minimum dimensions) with the cutouts being not less than 1½ in. [38 mm] in depth.

7.7.4 Strapping—When skids are used, strapping is required. Each skid shall be notched sufficiently to provide clearance for strapping.

7.7.5 Filler Cleats—Filler cleats shall be the same thickness as the end or side bottom panel cleats and not less than the width of the skids. Filler cleats shall be provided between each skid and the shipping container bottom panel. Filler cleats shall not be required for Style I boxes.

7.7.6 Nailing Skids—The skids shall be secured to the box by nails conforming to Specification F 1667, Type II, Style 18, and of such length as to penetrate a minimum of three fourths the skid thickness. These nails shall not protrude through the skid bottom surface.

7.7.6.1 Nailing Pattern—Nails shall be arranged in two rows in a staggered pattern, with spacing between nails in each row to be not more than 6 in. [152 mm]. Each nail row shall be approximately ½ in. [13 mm] from the skid edge, and the nailing pattern shall begin and end approximately 1½ in. [38 mm] from each skid end and shall not be nailed through the strap notch.

7.7.7 Type I and II, Additional Cleats—In addition to the weight requirements specified herein, boxes over 40 in. [1016 mm] wide and fitted with rubbing strip skids shall be provided with additional cleats attached to the underside of the box (see Fig. 7). The added cleats are provided to prevent damage to the floor panel by forklift tires.

7.8 Container Manufacturer's Identification—Unless otherwise specified (see 5.1.11), each panelboard box shall be marked with the following information and arranged in the following pattern as closely as possible:

7.8.1 Specification D 6251/D 6251M.

7.8.2 Box type, class, and style.

7.8.3 Box manufacturer's name and address.

7.8.4 Maximum contents weight (lb, kg, or both).

7.8.5 Load type.

7.8.6 Mod—When required, to designate that the box is in accordance with the specification requirements except for modification authorized in a contract or order (see 5.1.11.1).

7.8.7 All markings shall be permanent, legible, and shall be limited to a 24-in.² [15484-mm²] area placed on a side panel lower corner. Letters and numerals shall be approximately ⅝ in. [8 mm] high. The box specification number shall be in letters and numerals approximately ¾ in. [19 mm] high. When letters and numerals are indented, the indentation shall be not more than ⅛ in. [2 mm] below the wood surface.

7.8.8 Water-Repellent Wood Preservative Identification—The letters PA shall be permanently marked on all Treatment B boxes subjected to the 1.8 % oxine copper preservative treatment in accordance with 6.5. The letters PB shall be annotated in all Treatment B boxes subjected to the 3 % zinc naphthenate preservative treatment in accordance with 6.5.

7.9 Filled Boxes Assembly, Closure, and Strapping—Where this specification is referenced as a requirement for shipping of an item or items in a contract, order, or specification, the

Supplementary Requirements Section shall be a mandatory part of this specification.

7.10 Workmanship—No portion of a fastener-bearing surface shall protrude above the panelboard or cleat surface, nor shall it be overdriven more than ⅓ in. [1 mm] below the panelboard surface. Fasteners shall not be visibly deformed except where they are clinched. The panelboard shall be cut square and at no point shall the panelboard edge extend more than ⅛ in. [2 mm] over or ¼ in. [6 mm] under the panel size as determined by the cleat assembly.

8. Performance Requirements

8.1 Fastener Component Tests—The tests in 8.2 and 8.3 are intended to indicate the relative performance of various fastener types when used for wood-cleated panel box fabrication. Since these tests are comparative in nature, the appropriate cement-coated nail designated in 6.4.1 and of size specified for the purpose in Tables 9-11 must be tested concurrently with the alternate fasteners being considered to replace it.

8.1.1 Wood Test Specimens—Five test specimens are required for each fastener variety evaluated. Unless otherwise specified herein, these specimens shall be prepared from the same thickness and wood group as will be employed in box fabrication. The test specimen width shall be the same width as the container cleat sections in which the fasteners are planned to be used. No test specimen shall contain split members. Nails and other fastenings shall be driven so that neither the head nor the point will project above the wood surface, except when required for clinching where required. Specimens shall be cut and fabricated so that only side-grain nailing results.

8.1.2 Test Apparatus—The tests shall be performed on a compression tester equipped to produce force-deflection curves. The test specimen test fixtures, as illustrated in Fig. 8, shall be designed so that the applied force is perpendicular to the plane of the test member in contact with the loading block. Also, the test fixtures and loading blocks shall be dimensioned to provide clearances sufficient to prevent direct contact of the test specimen with the compression tester platens at any time during test prior to failure.

8.1.3 Test Procedure and Results—The platen speed shall be 0.4 ± 0.1 in./min [10.2 ± 2.5 mm/min]. Failure is denoted

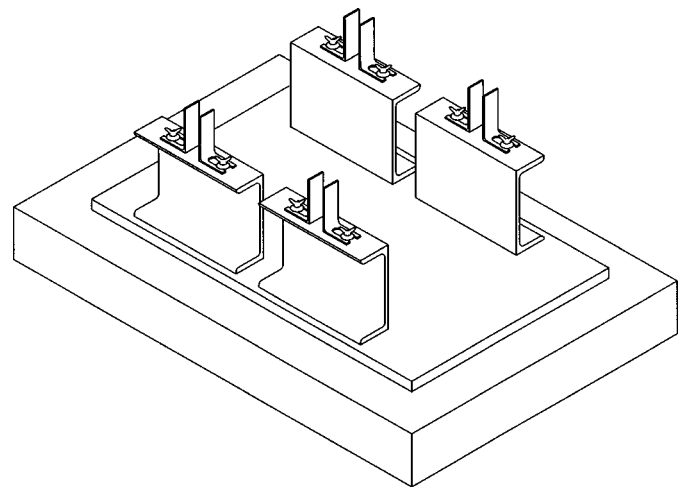


FIG. 8 Test Specimen Test Fixture

by the complete separation of one test specimen member from another in the specimen and shall be recorded in terms of the energy required to produce this separation. The required energy-to-failure value for each test specimen shall be determined by measuring the area under the force-deflection curve from the point of initial loading to the failure point. The average energy-to-failure values obtained with the nails and with the other fasteners shall be calculated and this data used to determine the total number of fasteners required.

8.1.4 Fasteners Required—The total number of fasteners shall be not less than the total number of nails that would be required. When additional fasteners are required, the increase should be limited to the number that can be used without splitting the box wood members during assembly.

8.2 Fastener Test for Securing Cleats to Panelboard Panels:

8.2.1 Test Specimens—The test specimen shall consist of two representative cleat stock sections measuring 14 in. [356 mm] in length. Each test specimen is secured with a test fastener as shown in Fig. 9, to the opposite edges of a representative container panel section measuring 6 by 12-in. [152 by 305 mm]. The two fasteners used to assemble the specimen shall be located as shown in Fig. 9 and shall be clinched not less than 1/8 in. [3 mm].

8.2.2 Test Fixture—The test specimens shall be mounted in a test fixture such as illustrated in Fig. 10. The test fixture rests on the compression tester lower platen. The compression load is applied to the wood-loading block that transmits the applied force to the specimen member representing the container end section. The loading block dimensions shall be such that the block covers the entire specimen member area it is in contact with except for a 1/4-in. [6-mm] clearance between the block sides and the adjacent cleat members. Specimen testing shall be performed as described in 8.1.

8.2.3 Type II, Class I, Adhesive Joint Water Resistance—If the fiberboard is fastened to the cleats by adhesive only (see 7.1.1), the adhesive water resistance shall be determined by

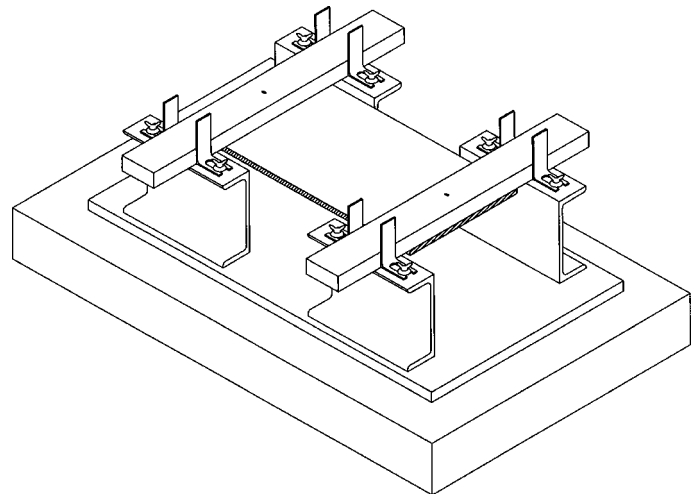


FIG. 10 Test Specimen/Fixture for Direct Withdrawal Resistance Test (Panel Assembly Test)

adhesion loss when exposed to water. Panel samples shall be made watertight, only at the corners where the cleats join, by applying a suitable material such as molten paraffin wax. The panel, cleats up, shall be filled with water at room temperature to 1/16 in. [2 mm] of the cleat upper surfaces. This water level shall be maintained for not less than 24 h. Each cleat in succession shall be torn from the fiberboard by hand, using the fingers. The fiberboard portion remaining in contact with the cleat shall cover not less than 75 % of the cleat area.

8.3 Fasteners for Container Assembly Test:

8.3.1 Lateral Resistance Test—The test specimen shall consist of two representative cleat stock sections, measuring 2 1/4 by 10 in. [45 by 254 mm]. Each specimen secured with one test fastener as shown in Fig. 11 to the opposite edges of a representative 6 by 6-in. [152 by 152-mm] container panel section. The two test fasteners used to assemble the specimen shall be located as shown in Fig. 11. The specimen test fixture (see Fig. 12) and the testing procedure shall be as described in 8.1.

8.3.2 Direct Withdrawal Resistance Test:

8.3.2.1 Test Specimens—The test specimen shall consist of a representative cleat stock section, measuring 3 by 10 in. [64 by 254 mm], secured with three test fasteners as shown in Fig. 13, to a representative container panel section measuring 5 by 6 in. [127 by 152 mm]. The fasteners used to assemble the specimen shall be located as shown in Fig. 13.

8.3.2.2 Test Fixture—The test specimens shall be mounted in a test fixture, such as illustrated in Fig. 14. The test fixture rests on the compression tester lower platen and the compression load is applied to the wood-loading block that transmits the applied force to the member representing the container panel section. The loading block dimensions are such that the block covers the entire specimen member area it is in contact with except for a 1/4-in. [6-mm] clearance between the side-walls of the slot in the wood loading block and the adjacent parallel test specimen surfaces. The slot depth should be great enough to prevent loading block contact with the portion of the test specimen within the slot at any time during testing. Specimen testing shall be performed as described in 8.1.

8.4 Water-Repellent Wood Preservation Test—Completely

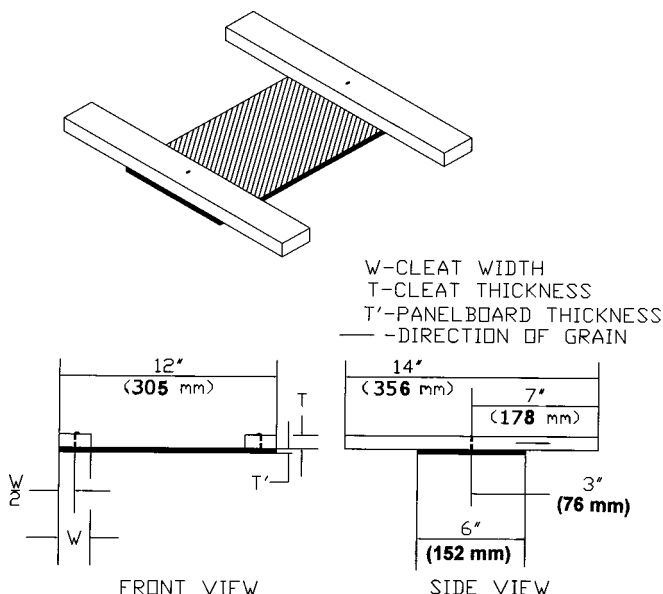
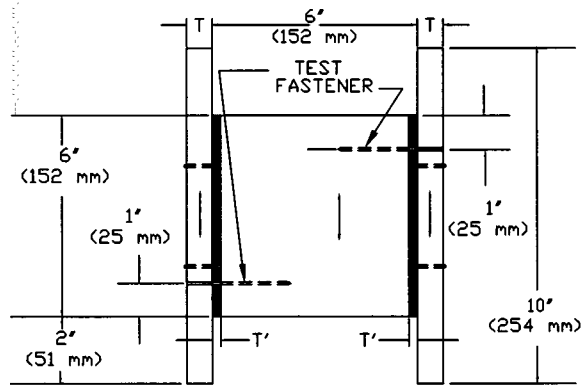
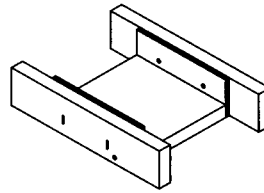


FIG. 9 Test Specimen for Direct Withdrawal Resistance Test (Panel Assembly Test)



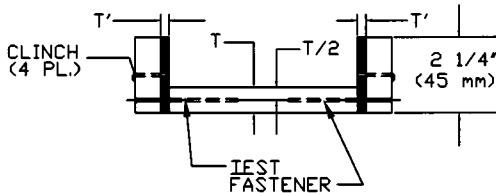
TOP VIEW



T—THICKNESS OF WOOD MEMBER

T'—PANELBOARD THICKNESS

— — DIRECTION OF GRAIN



END VIEW

FIG. 11 Test Specimen for Lateral Resistance Test (Container Assembly Test)

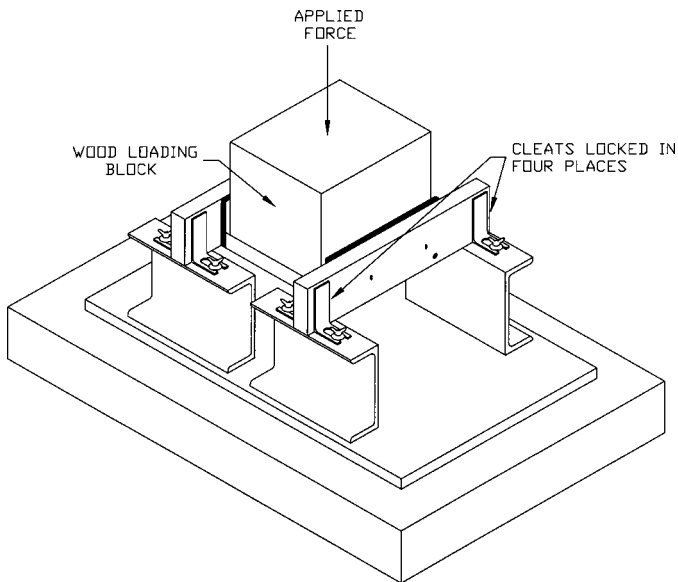


FIG. 12 Test Specimen Fixture for Lateral Resistance Test (Container Assembly Test)

assembled boxes shall be tested. An assembled box shall be placed on either end with top open. Any failure to meet the color requirements specified in 8.4.1 and 8.4.2 shall be cause for rejection.

8.4.1 *Oxine Copper Preservative Test*—Two drops of a formulation containing 10 parts, by weight, of sodium diethyl-

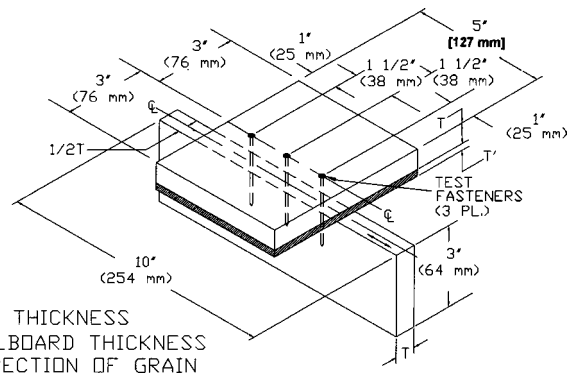
T—CLEAT THICKNESS
T'—PANELBOARD THICKNESS
— — DIRECTION OF GRAIN

FIG. 13 Test Specimen for Direct Withdrawal Test (Container Assembly Test)

dithiocarbamate trihydrate¹⁹ and 90 parts, by weight, of distilled water shall be applied to the wood surface. An immediate dark brown coloration and the drops spreading shall indicate the presence of treatment. An alternate method is to spray, over the dried wood surface, a solution of dissolved 0.5 g chrome azurol S concentrate²⁰ and 5.0 g of sodium acetate in 80 mL of distilled water, and diluted further to 500 mL total

¹⁹ Product may be obtained from Mallinckrodt Baker, Inc., 222 Red School Lane, Phillipsburg, NJ 08865. Chemical Abstracts Service (CAS) Registry Number 20624-25-3, (J.T. Baker Product Number 8624), or equivalent manufacturer.

²⁰ Product may be obtained from Fisher Scientific, 711 Forbes Avenue, Pittsburgh, PA 15219-4785. CAS Registry Number 1667-99-8, (Fisher Scientific Product Number AC190050250), or equivalent manufacturer.

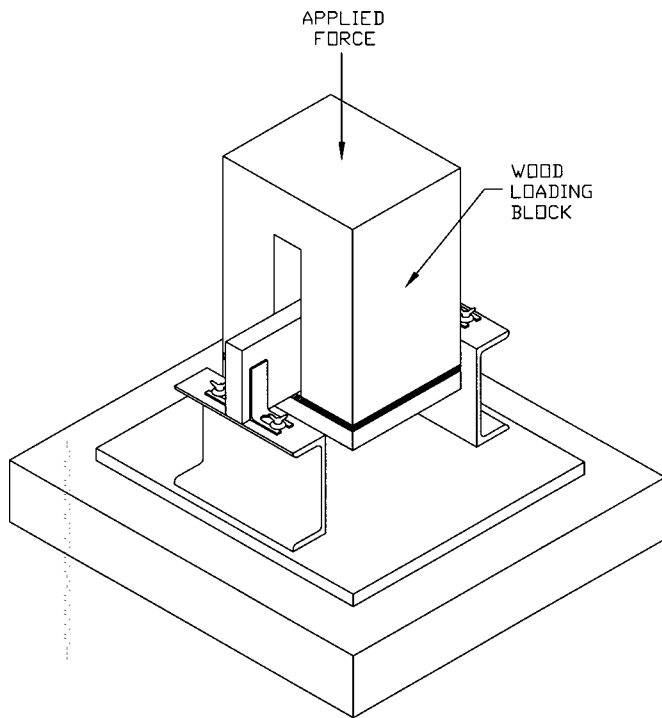


FIG. 14 Test Specimen/Fixture for Direct Withdrawal Resistance Test (Container Assembly Test)

distilled water. A deep blue color reveals the presence of copper (from oxine copper).

8.4.2 *Zinc Napthenate Preservative Test*—Prepare daily a solution of 0.1 g of dissolved dithizone (diphenylthiocarbazone)²¹ in 100 mL of chloroform and spray evenly over dried wood. A pink color indicates the presence of zinc.

NOTE 1—The pink color fades with light.

8.4.2.1 An alternate method is to prepare a mixture of 10 mL each of three stock solutions, and pour them in an atomizer (sprayer). The first stock solution is comprised of 1 g of potassium ferricyanide dissolved in 100 mL of distilled water. The second solution is made of 1 g of potassium iodide dissolved in 100 mL of distilled water with a starch indicator. The starch indicator solution is made from a paste of 1 g of soluble starch in about 5 mL of distilled water which is added to 100 mL of distilled water and boiled for one minute with constant stirring, and then cooled.

NOTE 2—This solution is subject to biodegradation and should not be used longer than three days.

8.4.2.2 Spray the mixture evenly over the dried wood surface. The solution will cause the treated wood to turn a deep blue immediately, and the untreated part will retain its original color.

8.4.3 *Preservative Dryness Test*—Completely assembled and knock-down boxes shall be tested for preservative dryness. An assembled box shall be placed on either end with top open.

A red oil soluble dye mixture consisting of 5 parts by weight of red oil soluble dye²² to 95 parts of borax, shall be prepared. The mixture shall be applied along the box interior juncture lines of the sides and bottom with the box end panel. Discoloration of the solution (red or deep pink) on any sample unit within 5 min from time of application when tested at 50°F [10°C], or above, shall be cause for rejection. Applying the solution to the components shall test knock-down boxes. Discoloration of the solution on any component shall be cause for rejection.

9. Shipping Preparation

9.1 Boxes are to be shipped completely assembled (except for tops) or knocked-down as specified (see 5.1.14). The tops for boxes shipped completely assembled, and like sized panels for boxes shipped knocked-down, shall be bundled, boxed, or crated, in quantities that permit easy loading and handling. Boxes shall be packed in a manner that will assure carrier acceptance and safe delivery to destination at the lowest rating in compliance with Uniform Freight Classification rules or National Motor Freight Classification rules. Preserved assembly instructions, if required, shall be secured in a protected location on the bundle, box, or crate of complete boxes or component panels.

9.2 *Packing and Marking*—Assembled or knocked-down boxes shall be packed and marked in accordance with Practice D 3951.

10. Notes

10.1 *Intended Use*—Boxes covered by this specification are used for domestic and overseas shipment of general materials and supplies. Style A and B are fully cleated and are stronger than Style I and J. Style A lends itself to ease in assembly and opening. Style B, with its three-way corner construction, has greater strength than Style A, but is more difficult to assemble and open. Style I and J provide greater water shedding ability than Style A or B. The unnailed top panel closure option for Style A, A1, or B is intended for use where shiners may damage contents or when box reuse is an important consideration.

10.1.1 *Class 1, Domestic Boxes*—Boxes are for domestic, offshore, and overseas shipments where protected storage and commercial type handling equipment is expected.

10.1.2 *Class 2, Overseas Boxes*—Boxes are for overseas shipments and handling in military and primitive type supply systems, subject to repeated handling and unprotected storage. These boxes may also be subject to extreme climatic hazards, temperature, and humidity conditions such as have been experienced in combat operations and undeveloped areas. The contents weight and load type (see 4.5) determines construction.

10.1.3 *Subsistence and Clothing Shipments*—Subsistence or clothing shipments shall not be made in boxes fabricated from toxic-treated wood or panelboard.

10.1.4 *Regulated Commodities Shipments*—Regulated commodities shipments may require stronger constructed boxes

²¹ Product may be obtained from Mallinckrodt Baker, Inc., 222 Red School Lane, Phillipsburg, NJ 08865. CAS Registry Number 60-10-6, (J.T. Baker Product Number K98302), or equivalent manufacturer.

²² Product may be obtained from Keystone Aniline Co., 2501-T W. Fulton Street, Chicago, IL 60612, Product Number 7WB Concentrate, or equivalent manufacturer.

than those specified herein. When the US Department of Transportation regulates commodities, all boxes must conform to the requirements of CFR Parts 107-180 Title 49, Hazardous Materials Regulations or appropriate international modal regulations.

10.2 *Load Type* (see 4.5, 7.2.2, and 7.2.3)—Type 3, Class 2 box construction is determined by the contents weight and load type. Load types are defined as Type 1, easy load; Type 2,

average load; and Type 3, difficult load; as described under “Load Type” in Terminology D 996.

11. Keywords

11.1 box; cleat; cleated-plywood; container; fasteners; nails; packaging; panel; panelboard; shipping container; skid; staples; wire stitches; wood

SUPPLEMENTARY REQUIREMENTS

S1. Scope

S1.1 These supplementary requirements cover the application and inspection of steel strapping for wood-cleated panelboard boxes. When specified (see 5.1.15), Class 1 boxes shall be strapped in conformance with these Supplementary Requirements. Unless otherwise specified (see 5.1.15.1), Class 2 boxes shall be strapped in conformance with these supplementary requirements and the references cited herein. In the event of a conflict between this specification and the references cited herein, this specification takes precedence. Nothing in this specification, however, shall supersede applicable laws and regulations unless a specific exemption has been obtained.

S2. Strapping Requirements

S2.1 *General*—Strapping required herein shall be performed when the box is packed for shipment. Strapping materials shall be furnished by the box packer and shall be flat metal strapping conforming to Specification D 3953, Type I, Regular Duty, Grades 1 or 2.

S2.2 *Strapping Size*—The strapping size shall be as given in Table 12.

S2.3 *Tensile Strength*—The seal joint strength shall be not less than 75 % of the tensile strength of the flat or round wire, strapping, as applicable, when tested as specified in S3.2.

S2.4 *Tightness*—The straps shall be drawn tight so as to sink into the wood at the edges. Unless otherwise specified herein, straps or wires shall be stapled to the cleats at a distance not to exceed 4 in. [102 mm] from the box edge or face with cement-coated or chemically etched staples, spaced approximately 6 in. [152 mm] apart. Strapping on the box bottom shall not be stapled. Strapping applied over box top panel filler edge

cleats shall not be stapled. Strapping used for unnailed closure boxes shall not be stapled. One staple shall be applied over each strap into the through edge cleats on the box top panel. Staples shall be not less than 0.080 in., (14 gage), [2.032 mm] in diameter, in accordance with Specification F 1667, or the equivalent cross-section area, unless machine driven, in which case the staple shall be not less than 0.0475 in., (18 gage), [1.207 mm] in diameter. The staple length shall be approximately $\frac{3}{4}$ in. [19 mm]. When driven over flat strap, the staple shall be approximately $\frac{1}{8}$ in. [3 mm] wider than the flat metal bands. Staples shall be driven so as not to damage the strapping. Staples shall be applied just prior to shipment, where practicable.

S2.5 *Location and Number of Straps*—All straps shall be applied perpendicular to the box edge and be positioned only over the cleats of the applicable box style. Two straps shall be applied lengthwise to the box on the edge cleats over the ends, top, and bottom for Style A and B. Two straps shall be applied lengthwise (horizontally) to the box on the edge cleats over the ends and sides for Style I and J.

S2.5.1 *Intermediate Cleats*—When intermediate cleats are required on the sides, top, or bottom, a girth-wise strap shall be located over each intermediate cleat and shall be positioned on top of the longitudinal straps. When an intermediate cleat is required on an end panel, strapping shall not be required over this intermediate end cleat.

S2.5.2 In applying straps, care must be exercised so that straps do not pass over voids between cleats and thus become susceptible to snagging. Alternatively, each lengthwise and girthwise strap may be replaced by three corner flat straps each 8 in. [203 mm] long and secured to the container by three staples on each leg pneumatically driven through the strap into the cleats. The flat strapping shall be the same width, thickness, type, finish, and grade as specified in S2.1 and Table 12. Alternatively, the strapping may be the nail-on type. Corner straps (nail-on) shall not be used on Style A, A1, and B unnailed top panel closure boxes.

TABLE 12 Flat Metal Band Sizes

Contents Weight, lb [kg]	Flat Metal Bands Dimensions When Different Numbers of Bands Are Used, in. (mm)	
	2 Bands	3 or More Bands
Up through 70 [31.8]	$\frac{3}{8}$ by 0.020 [9.52 by 0.51]	$\frac{3}{8}$ by 0.020 [9.52 by 0.51]
71 through 125 [32.2 through 56.7]	$\frac{3}{8}$ by 0.020 [9.52 by 0.51]	$\frac{3}{8}$ by 0.020 [9.52 by 0.51]
126 through 175	$\frac{1}{2}$ by 0.020	$\frac{1}{2}$ by 0.020
[57.2 through 79.4]	[12.70 by 0.51]	[12.70 by 0.51]
176 through 250	$\frac{5}{8}$ by 0.020	$\frac{5}{8}$ by 0.020
[79.8 through 113.4]	[15.87 by 0.51]	[15.87 by 0.51]
251 through 400	...	$\frac{3}{4}$ by 0.020
[113.9 through 181.4]		[19.05 by 0.51]
401 through 1000	...	$\frac{3}{4}$ by 0.023
[181.9 through 453.6]		[19.05 by 0.58]

S3. Performance Requirements

S3.1 *Seal Joint Test*—Unless otherwise specified in S3.1.1, three separate joint specimens shall be taken from sample strapped boxes and tested as specified in S3.2. If the seal strength of one or more of the three specimens is less than the requirements of S2.3, it shall be cause for rejection.

S3.1.1 When specified (see 5.1.16), three separate joint specimens shall be made and submitted for test as specified in

S3.2. These specimens shall be made prior to strapping containers and are required each time a different strapping reel, tools, or kind of seal is used. If the seal joint strength of one or more of the three specimens is less than the requirements of S2.3, it shall be cause for rejection.

S3.2 *Seal Joint Tensile Strength Test*—The seal joint shall be tested in accordance with Specification D 3953.

S3.3 *Specification Part Number*—A specification part number can be formulated to identify each item. The part number can be formulated by selecting from the requirement options available in this specification.

S3.3.1 *Part Number Format* (See Fig. 15):

S3.3.1.1 *English Example*—Type I, Class 1, Style A1, Treated, Load Type 3, 48-in. length, 24-in. width, and 48-in. depth box.

(a) D 5251 IXX 1 A1 B 3 48XX 24XX 18XX.

S3.3.1.2 *Metric Example*—Type III, Class 2, Style J, Untreated, Load Type 1, 1219 mm length, 610 mm width, and 457 mm depth.

(a) D 6251M III 2 JX A 1 1219 610X 457X.

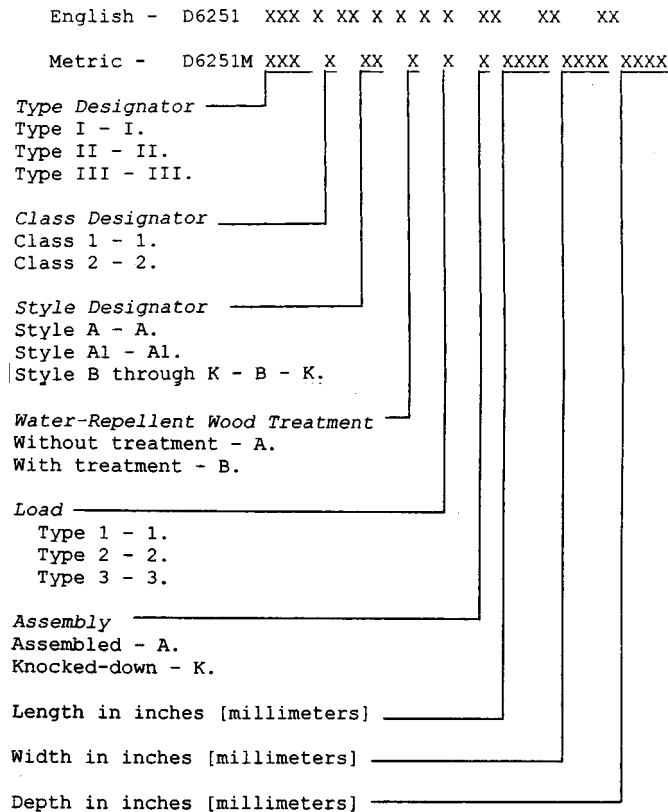


FIG. 15 Part Number Format



D 6251/D 6251M

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